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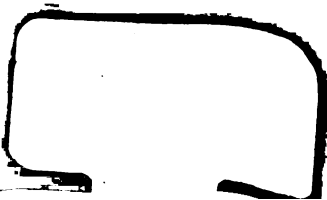
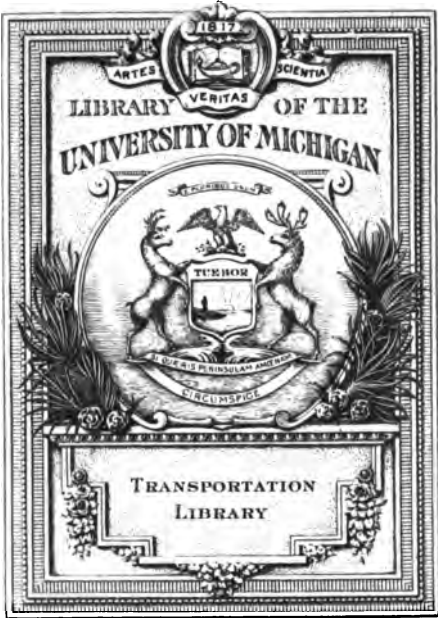
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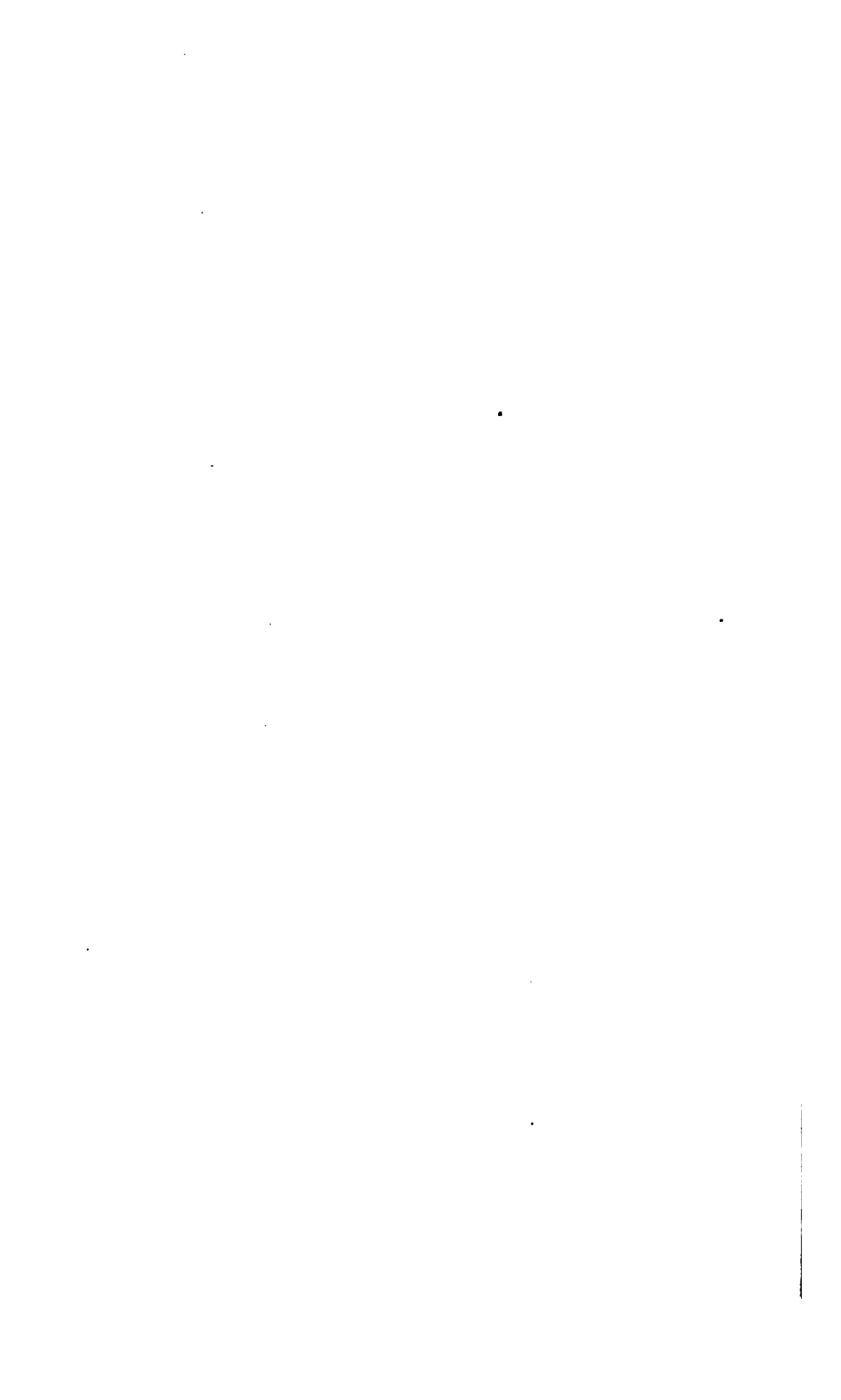
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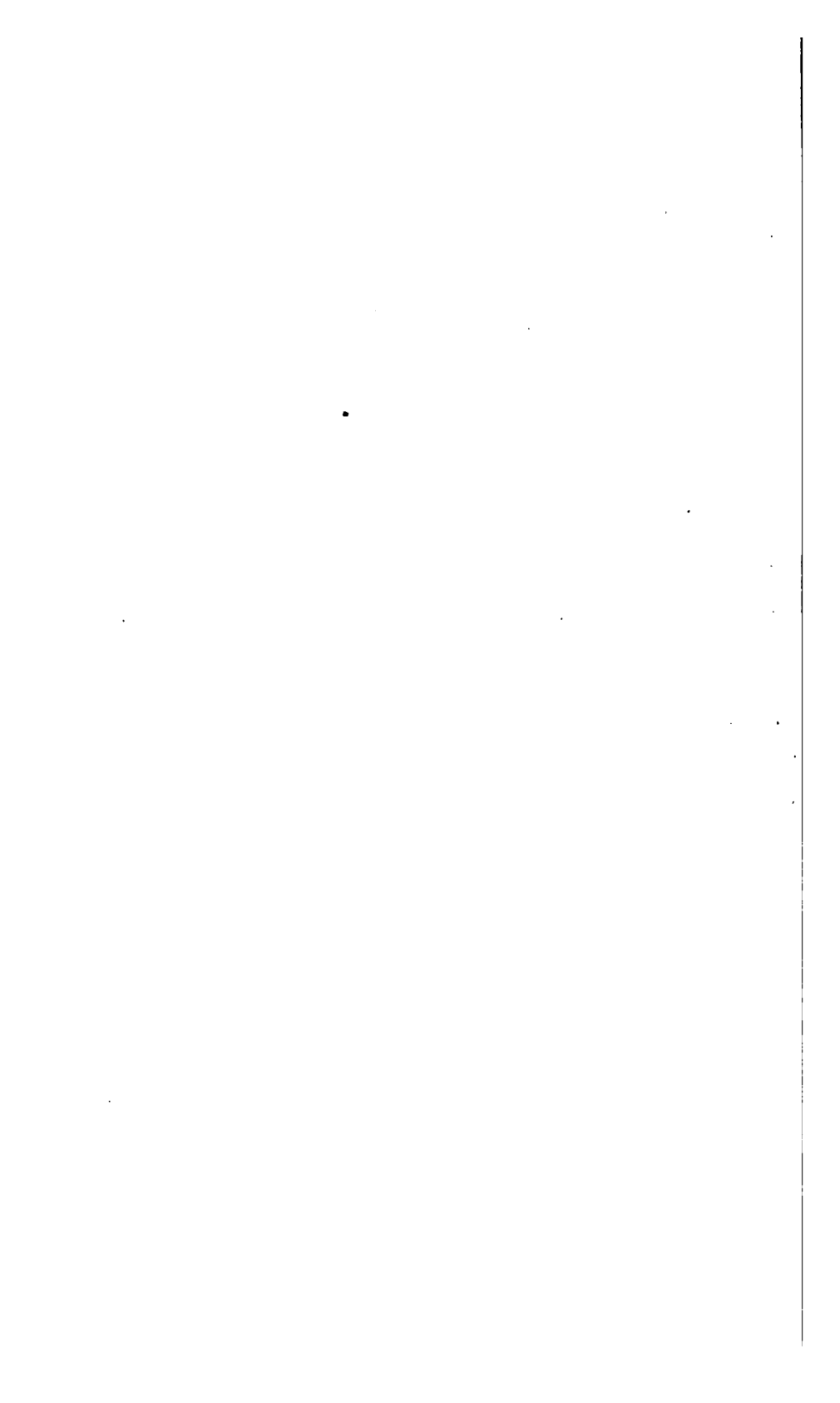


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PAPER 2043

ON THE

THUL GHAUT RAILWAY INCLINE:

READ AT THE

**BOMBAY MECHANICS' INSTITUTION,**

IN THE TOWN HALL,

ON MONDAY, DECEMBER 10, 1860,

BY THE PRESIDENT,

**JAMES J. BERKLEY, ESQ., M.I.C.E., F.G.S.,**

CHIEF RESIDENT ENGINEER OF THE GREAT INDIAN PENINSULA RAILWAY.



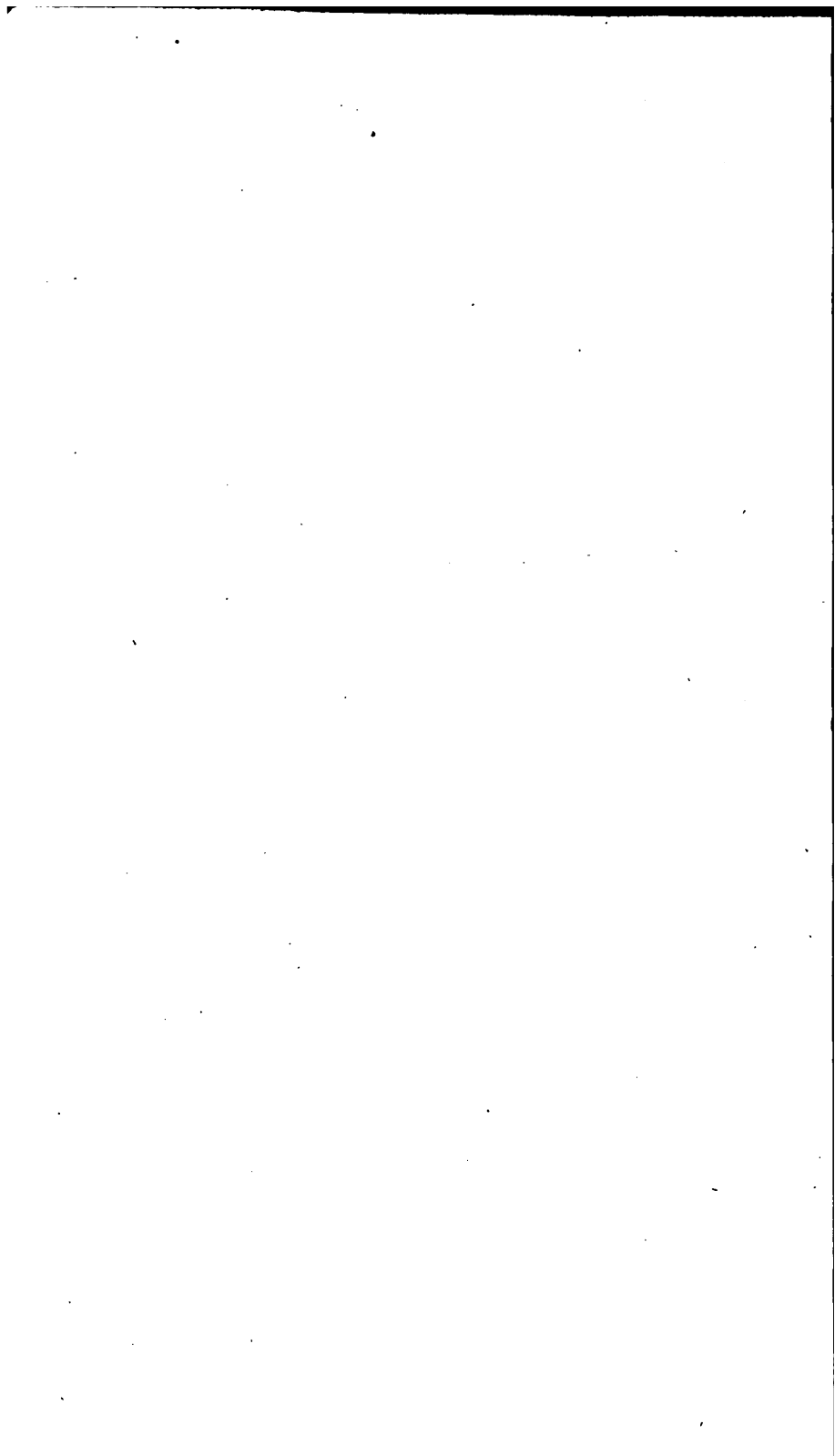
THE GREAT INDIAN PENINSULA RAILWAY

**Bombay:**

PRINTED AT THE

EDUCATION SOCIETY'S PRESS, BYCULLA.

1861.





1927/40  
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## THUL GHAUT RAILWAY INCLINE.



It affords me great pleasure to observe on the present occasion such bright prospects for this Institution,—brighter, perhaps, than have ever dawned upon any previous inauguration of our Annual Session. I rely not merely upon the fact of our numbers having increased during the past year, but if any one will examine our Nominal List of Members, and remark the signs of active enterprise now rife in this metropolis, it will be evident how much material we possess for procuring excellent contributions for our weekly meetings, and what varied classes of the inhabitants are associated to afford an audience capable of appreciating the unusually interesting course of miscellaneous lectures in the programme of our proceedings. There is, perhaps, no other society in the Presidency, which embraces so numerous a body of practical and well-informed men, whose daily pursuits enable them to acquire a wide and valuable experience in industrial occupations. There is certainly none which has the advantage of an equal amount of co-operation between European and Native gentlemen of intelligence. The many manufacturing establishments which are being erected in this Presidency open an expanding field for our researches and discussions, and we may therefore reasonably hope that the regard which our Members entertain for the public character of the Institute, and that liberal spirit which disdains to withhold useful information from their fellow-townsmen, will prompt them to render an active and willing assistance in the business of the ensuing Session.

One event, however, has recently transpired which this Institution, as well as the community at large, must deeply lament; and, as the continuance of the recess deprived us of an earlier opportunity of giving utterance to our sentiments, I venture, on your behalf, to do so on the present occasion. I allude to the death of our late

Patron, who always evinced a lively interest in our success, and from whom we derived several of the privileges we enjoy. Lord Elphinstone entered upon his high functions with the obvious intention of fostering the arts of peace in India, and of promoting the welfare of the people of this country. We cannot fail to remember the efforts which His Lordship made to extend to Education in all its branches the liberal assistance of the State. The Bombay University was founded under his auspices; the Grant College, Elphinstone Institution, the Poona College, the Central Museum, the School of Industry, the Native Girls' School;—in fact, every establishment which had for its object the improvement of the community, reaped the benefits of his unwavering countenance and support. The Mechanics' Institution will, I am sure, hold in grateful remembrance the advantages which it derived from his patronage. He granted us the privilege of holding our Meetings in this Hall, and procured for us a Government contribution towards the expenses of our annual lectures. He presented us with a valuable addition to our Library, and lost no opportunity of recognising the public merits of the Institute, by forwarding copies of any Government Records which could find an appropriate place upon our shelves. If, in the midst of his peaceful projects, Lord Elphinstone was compelled to relax exertions which had been his pride and delight, we all know with what reluctance he consented to forego any cherished objects of his administration, and with what tenacity he clung to them, even at a time when public events of an alarming nature had aroused his courageous spirit, and were straining all the faculties of his mind.

There can be little doubt that Lord Elphinstone returned to India in the full expectation of enjoying an era of public tranquillity for the prosecution of his enlightened schemes. Yet Providence so diverted the current of events, that he who had aspired to win his laurels by the triumphs of a peaceful policy, gained his greatest renown by bold and successful measures for the defence, not of his own Presidency alone but of the Indian Empire! It is a fact which this Institution will not, I feel sure, pass over without a grateful acknowledgment that, while mutiny and disorder prevailed throughout so large a portion of India, we had one of its staunchest and wisest, yet most unostentatious, defenders at the helm of affairs; and that so well did he ward off the impending danger from our

precincts, that all our learned societies in Bombay passed through that eventful period without suffering any material injury to their interests, or interruption to their proceedings. It is not my intention, indeed it would be unbecoming in me, to eulogise the public career or character of the late Governor of this Presidency ; still, in addressing so large an assembly of our Members, and in presence of yonder silent monitor,\* it would be a dereliction of my duty, as your President, were I to omit some respectful tribute to the memory of so good a patron of this Institution as Lord Elphinstone.

I have selected for the subject of my address a description of the Thul Ghaut Railway Incline ; and the interest which has been already manifested, both here and at Home, in my previous Paper upon the Bhoze Ghaut Incline, encourages me to indulge a hope that this may also be considered worthy of your attention. Three years have now elapsed since the description of the Bhoze Ghaut Incline was read to you in this Hall, and our subsequent operations have tended to impress me more strongly than ever with the conviction that these important works, with all their various effects upon the labour and industry of this part of India, ought not to be carried on without some attempt being made to promulgate a knowledge of them through the medium of this popular Institution. I invite, to these Railway ascents of the Syhadree Mountains, the attention of all men who are concerned in the commerce and prosperity of this Presidency, because certainly they are, in point of magnitude and practical characteristics, among the most remarkable Railway works of the age ! They are situated, too, in a country where, with all the advantages of the national enterprise, and the Government support of England, success, economy, and despatch depend upon the resources of a foreign land.

Measured by their political and commercial importance, it is needless for me now to prove how great will be the public gain by their completion. The passage of the Ghauts has always been a costly and serious obstruction to the trade of India, yet never were its effects more deeply and widely felt than at the present moment ; for with all the benefits of Railway communications provided upon the Concan below, and the Deccan above the Ghauts,

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\* The Statue of Mountstuart Elphinstone.

the utmost capabilities of our Lines are contracted within the narrow limits of the carrying power of the common roads. Experience has already brought home to us, with peculiar force, the want of this important link in the Railway communication between Bombay, Poona, and Sholapoor; and in the course of a few weeks more, we shall find ourselves in the same predicament with our North-Eastern Line to Nassick.

Although these are the more prominent points which recommend the construction of the Ghaut Inclines to public notice, yet there are many other particular features which endow them with a special claim upon the attention of the Members of the Institution. The rapid progress of the works, and the employment of new mechanical appliances for expediting or economising their execution, now render them worthy of the study and examination of practical men. The large quantity and variety of imported materials; the activity given to native trade; and the stimulus, derived by native manufactures, from the special requirements of the Railway, are also subjects of commercial importance; while none who, as statesmen, projectors of public works, or agents for their construction, are concerned in industrial enterprise, can fail to take an interest in the enormous demand for labour, in the local sources, and the means of its supply; in the increased efficiency of every class of Indian workmen, and in the rapid rise of wages they command.

Among the principal difficulties which it was anticipated we should have to encounter in the execution of these immense works was an inadequacy in the supply of labour; and many, whose opinions were entitled to be heard with deference, expressed serious fears upon that point. I confess, that I for one have never been a sharer in those misgivings, and it is my impression that they originated in a contracted view of the resources of the country. If I adduce an illustration to show the groundlessness of the apprehension, do not understand me to give you an exact case which will bear the test of the close reasoning of practical men; but I stand upon its correct representation of a general truth. Look at India with its 186 millions of population; take one-sixth of them as adult males, and you have twice the number of men, who, if it were practicable to employ them simultaneously, could finish either of the Ghaut Inclines in one single day!

In such a populous country as this, and with the prevailing prices

of labour at a minimum, it has always appeared to me to be impossible that the liberality and devices of English enterprise could so fail in their operation upon the industrial classes of India, as not to procure an ample supply of labour for the completion of undertakings materially affecting the prosperity of commerce, the public revenue, and the convenience of the people. In proof that the adverse anticipations of others were ill-conceived, I have only to mention that, at the present moment, we employ more than 30,000 men upon the Bhore Ghaut Incline, extending over only 14 miles of Railway; that this enormous body is collected from all quarters of the country,—from Bombay and Hyderabad, from Gwalior and Goa, from Ahmedabad and Kolapore, from Broach and Dharwar; from Tanna, Sholapore, and Rutnagherry, Sattara, Belgaum, and Poona, from Sawunt Warree and the Concan; and that it comprises 32 different classes of artizans and labourers, of whom there are 10,822 drillers and 2,659 masons.

This success has been achieved by the liberal and judicious management of Messrs. Adamson and Clowser, in the face of the greatest local disadvantages, in spite of visitations of Cholera, of casualties among European Superintendents, and with an urgent and immense demand for labour in the large presidential towns, and along the whole range of our Railway operations. Nor can it be affirmed that the abundance of one district of the works deprives another of its men; for with a complement at the Bhore, we are employing large numbers at the Thul Ghaut. The great difficulty consists not in procuring hands, but in retaining them where the labour is hard, provisions dear, and all the circumstances militate against their health and comfort.

I must dwell no longer upon entertaining topics such as these; yet, if a dry and matter-of-fact narration of our proceedings upon the Thul Ghaut Incline should fail to excite that interest which professional men are sure to take in a subject so akin to their pursuits, I entreat you to regard it in the light of its public importance, and to esteem it according to its statistical and national value.

An impression may, perhaps, pervade the minds of some now present, that the resemblance between the two Inclines up the Bhore and Thul Ghauts may throw a sameness over the treatment of the latter. My knowledge of both, however, enables me to assure you that this is a misapprehension, and to explain how

general is the analogy that subsists between them ; for when entering upon the details of the comparison, I am myself struck with the remarkable diversity which is apparent in passing from the ascent of one portion of the Syhadree Range to the other, where we are now constructing the Main Line from Bombay to Calcutta. Although, in some measure, an anticipation of the facts which my description will embrace, it may serve to elucidate the subject if I now mention some of the peculiar features in which both a resemblance and a contrast may be traced between the two Inclines.

Both of them ascend the same chain of mountains, in which the geological formation is similar. \* The altitudes of the two Ghauts closely correspond ; the summit of the Bhore Ghaut Incline being 2,027 feet, and that of the Thul Ghaut 1,912 feet above the sea. Both of the ascents are effected in proximity to the public Mail Roads. The maximum gradient of both Inclines is the same, being 1 in 37. The extreme curvature is almost identical, that of the Bhore Ghaut being 15 chains, and of the Thul 17 chains radius.

The character of the Incline has, in each case, been improved by the adoption of the same contrivance of a Reversing Station, and under singularly parallel circumstances. The same description of Permanent Way is being adopted for them both. In local peculiarities, we find the same difficulty in procuring a due supply of water for our labourers and works.

With regard to healthiness, it is mournful to reflect that upon both Inclines the lives of the two gentlemen, who had undertaken their construction, fell a sacrifice to their arduous labours and exposure to the climate. I deeply deplore this melancholy coincidence : for, by the death of Messrs. S. Tredwell and Jackson, not only has the Railway system of India, but that of England, lost two of its most skilful, experienced, and upright contractors. And here, unless we descend to details of work possessing very little claim upon our notice, the resemblance ceases.

The points of variance between the two Inclines are numerous and remarkable. It is true that they traverse the same chain of mountains, yet the clue to the laying out of the Railway in each case was as different as can well be conceived. For instance, at the Bhore Ghaut the course of the great ravine of the River Oolassa defined the general route of our Railway ascent from the base to



the summit; whereas at the Thul Ghaut, the accidental existence of the Koshen, Lara, and Mussoba Khinds, ~~or passes through the hills,~~ were our principal guide to the selection of the ~~line~~ we are constructing.

They cut through the same geological formation: but upon the Bhore Ghaut we frequently find the mountains precipitously scarp'd, and have to deal with deep faces of bare rock. Not so upon the Thul, for the physical contour of the hills generally presents an undulating surface, and the rock is covered with a thick superstratum of moorum and boulders, so that it is only for short lengths near the summit that an escarpment is encountered. In the tunnels of the Bhore Ghaut Incline we have certainly exposed several varieties of trap-rock with which our geologists are familiar; but in the estimation of a miner they are invariably hard. The circumstances in the Thul Ghaut tunnels are of a very different nature; for there we have to deal with extremes of hardness, earthiness, dryness, and a copious flow of water. Again, in the minerals of the rocks, the class of zeolites abound in both Inclines; yet our excavations at the Thul Ghaut have disclosed specimens very unlike those in the Bhore Ghaut collection. The crystals are of precisely the same species it is true, but they are of varied colours and tones of colour, and concreted in new combinations. So marked are these peculiarities, that on the receipt of specimens which I have forwarded to the Trustees of the British Museum, Professor Maskelyne, the Superintendent of the Mineralogical Department, has written to me in terms of delight at the novelty and beauty of the crystals from the Thul Ghaut Incline; and while upon this subject, it will surely gratify the meeting if I inform them that that eminent authority pronounces the Thul and Bhore Ghaut zeolites, which are now in the British Museum, to be unrivalled by any scientific collection in Europe. If you will examine the fine specimens upon the table, some of which are placed apart as coming from the Bhore and others from the Thul Incline, they will be found to present sufficient evidence of the distinctions which characterise the mineral productions of these two districts of the Ghauts.

The altitudes of the two Ghauts above the sea are, as I have already stated, very nearly equal upon both ascents; yet the height to be surmounted by the Thul Incline proper, is only 972 feet as compared with 1831 feet upon the Bhore. This great disparity in

the height of the Inclines arises from a remarkable variation in the physical geography of the two districts ; for while at the Bhere Ghaut the mountain spur abruptly terminates at a distance in a straight line of only 11 miles from the crest of the main range, that upon which the North-Eastern Extension has been laid out stretches for 30 miles westwards into the Concan, and ends in scattered hills within a short distance of the sea-shore. Although a public road exists in the vicinity of both Ghauts, they afford very unequal facilities to our works. The Bhere Ghaut road is steep, tortuous, and ill-made ; nor does it touch upon the Line, or yield us any accommodation, except on its near approach to Khandalla. On the other hand, the Thul Ghaut road is a masterpiece of engineering, and is in no part distant from the Railway Works. Indeed, for 7 out of 9½ miles, it lies within a stone's throw of them. It has been compulsory to adopt the same maximum gradient of 1 in 37 along a portion of both Inclines, yet at the Thul Ghaut we have been able to flatten the plane to a very considerable degree for a distance of nearly one-third the ascent. Upon the Bhere Ghaut we have derived some advantages from the Station of Khandalla with its bazar and water-supply, while in the vicinity of the Thul Ghaut the villages are small and remote. Egutpoora, and especially Kussarah, have, however, greatly increased, and appear at the present time to be reaping the benefits of our works by a thriving trade. Both of the Inclines possess the peculiarity of presenting upon their section an enormous mass of heavy work ; and although in this respect the magnitude of the Bhere Ghaut Incline very far surpasses that of the Thul, yet we have been compelled upon the latter to design works of grander dimensions ; and its longest Tunnel and Viaduct exceed anything to be met with on the Bhere Ghaut Section. Indeed, the unusual proportions of the Ehegaum Viaduct have driven us to another distinguishing expedient, in the adoption of iron girders of 150 feet span, instead of the stone arches, which it has been our practice to build at the Bhere Ghaut.

Notwithstanding the painful coincidence of the death of our two Resident Contractors, the Inclines differ even in point of salubrity. There have been frequent visitations of Cholera at the Bhere Ghaut, and two of an alarming character occurred in the course of last season ; yet at the time when the workmen's huts were being burnt

as a sanitary measure, and the labourers were being scared away by thousands from the Bhore Ghaut Incline, the disease never made its appearance on the Thul. There is one other discrepancy of practical importance with which I shall close this comparison. It is the fact of the Railway having been opened to the foot of the Bhore Ghaut Incline at the commencement of the works, whereas upon the Thul Ghaut we have had for the last three years to labour at the haulage of our heavy materials along an indifferent road from Wassind to Kussarah. This description will serve to show that, while in some general points the two Inclines are strictly analogous, they display many essential and peculiar features, which materially distinguish them in their scientific aspects, as well as in regard to construction, and to the working properties of the Railway.

I now proceed to the narrative of our preliminary, official, and practical operations in laying out, improving, advocating, and constructing the Thul Ghaut Incline. In the year 1847, prior to the incorporation of the G. I. P. Railway Company, the Northern Concan was professionally examined for the purpose of discovering an eligible line to the Thul Ghaut. This, however, was attended with unfavourable results, and Mr. Chapman, the introducer of the Railway System into Western India, published, in the year 1851, his belief, that it was improbable that even a really good common road would be found across the Northern Concan to the Ghauts in that direction. The observations of the Engineer, upon whose report this opinion was recorded, appear to have been confined to an examination of the Basta Valley to its junction with the River Chernal, beyond which the country presented physical obstacles to the construction of a Railway.

In the year 1851 I proceeded, for the first time, to look at the tract of country by which the Thul Ghaut might be approached. My inspection on that occasion was only of a general nature, for the object we then had in view was merely to determine what extent of survey would be requisite for laying out the Railway ascents of the Ghauts, and what period of time the investigation of the merits of the various routes would be likely to occupy. We ascertained during that season, that although the ground across the Northern Concan was of a formidable nature, and covered with a dense jungle, yet the altitude to be surmounted at the Ghaut was less than at any other point we had observed; and that the great length

of the mountain spur would afford advantages for attaining a considerable elevation for the Railway before it reached the base of the Incline. I therefore recommended that the long and difficult operation of laying out a trial line between Callian and the summit of the Thul Ghaut should be carefully undertaken in the ensuing season. Accordingly, in 1852, this survey was begun; and in our first efforts to obtain a practicable line to the foot of the Ghaut at Kussarah, we were baffled by the tortuous and precipitous character of the valley of the Basta above its junction with the Chernal—so far corroborating the opinion of our predecessors. We afterwards directed our attention to the rough ground upon the south flank of the irregular spur, or range of hills, which extends from the Thul Ghaut for upwards of 30 miles past Khurdee to the north of Shawpore, in a direction generally coinciding with that of the Bombay and Agra Road. Notwithstanding the impediments of high projecting rocks, and deep ravines connected with the mountain ridge, which divides the River Basta from the Rivers Tannsa and Wyturnee, we succeeded in laying out a line past Wassind, Shawpore, and Khurdee to Kussarah, tolerably straight in direction, with a rising gradient of 1 in 100 for nearly two-thirds of its length, and by that means, on reaching the base of the Incline, we surmounted nearly one-half the elevation of the Ghaut. These were no equivocal advantages in the line of country we had selected for the approach to the Thul Ghaut Incline, and which fortunately lay along the present course of the traffic of the Agra Road. Indeed, throughout our extensive examination of the Ghauts we have seen no other spur of the range at all comparable to it for Railway purposes.

This peculiar and favourable feature upon our North-Eastern Extension, or what may be better understood by the denomination of "the Bombay and Calcutta Line," is remarkable, and strongly contrasts with the South-Eastern, or "the Bombay and Madras Line." Upon this we could only approach the Syhadrees by the easy rise of the Concan Valley of the River Oolassa, and as a necessary consequence, the whole mountain lift was concentrated within the narrow limits of the Ghaut margin, and a comparatively short projecting spur; while upon that we discovered the means of attaining more than half the altitude of our summit before we reached the vicinity of the main escarpment. The section from Callian to Kussarah, nevertheless, contained many formidable works; for although the

contour of the ground enabled us to obtain much flatter gradients than prevailed upon the Ghaut itself, yet from Wassind to Kussarah the line was, in point of fact, a part of the Ghaut ascent, and its construction has been attended with many of those unusual difficulties which are met with in so aggravated a form upon the two Inclines.

Some years ago Mr. Langford, who was then Collector of Ahmednuggur, denounced this route in the following terms:—"I doubt much if you could have found a line for a Railway from Shawpore to Kussarah, because in parts the country is very rugged, having many deep ravines that would have been great obstacles to the works; added to which, this Line is at certain seasons a particularly unhealthy one,—in the rains a deep jungle; and Kussarah, which you must have made a halting-station, about as deadly a place as any I am acquainted with, the fevers caught there being fatal ones."

So late as July 1854 Lord Elphinstone likened the construction of a Railway to the foot of the Thul Ghaut, in point of healthiness, to that of a line laid out through the Dang Jungles, and in his Lordship's minute he wrote emphatically thus:—

"I fear that whichever way the Railroad is made, we must be prepared for very numerous casualties. Every possible means must be taken to lessen the risk, and to reduce the number of victims; but it would be as idle to expect that we shall carry on a victorious campaign on the Danube without loss, as that we should successfully overcome the physical difficulties with which we have to contend in making railroads through such a country as India without a certain and heavy sacrifice of human life."

Believe me, these are no over-wrought representations of the state of the country; for from personal observation, I can bear testimony to their accuracy. I have travelled from Callian to the Thul Ghaut during a season when all the villages were depopulated by disease, and when the inhabitants had taken refuge upon the mountains, where the nightly fires indicated the spots of their temporary abode. Yet, notwithstanding the appalling nature of the locality, the want of water, and the scantiness of the population, a line, presenting works of the greatest magnitude, and demanding an immense concentration of labour and materials, is now on the eve of being opened; and it redounds greatly to the credit of our enterprising Native contractor,

Mr. Jamsetjee Dorabjee, that this important object has been accomplished with unqualified success, with extraordinary despatch, and at a cost which, considering all the circumstances, must be regarded as extremely moderate.

From the termination of this remarkable section of the Railway, the original Incline of the Thul Ghaut commenced on the south side of the village of Kussarah, and its course is indicated on the Map by the *red* line. After crossing a gorge of the Kussarah Nullah it wound for nearly half a mile over some rough, rocky ground, and ascended for two miles the southern flank of the spur overhanging the great Basta ravine. The Line then crossed by a low pass over to the northern flank of the Beulah mountain, and after twice crossing the new Thul Ghaut Road, entered a tunnel through a projection opposite the Toll House, and above the Mussoba Khind. On emerging from that tunnel, it again crossed the public road, and keeping closely to its course, cut through two hills, and then perforated the most formidable of the mountain projections along its route by a tunnel 462 yards in length. It thence crossed the very wide and deep ravine at the head of the Ehegaum Nullah by a viaduct 172 yards long and 157 feet in extreme height, pierced two more hills by tunnels, crossed another large ravine by a viaduct 100 yards long and 120 feet high, and ascended through heavy cuttings and across the intervening nullah-beds to the hill over which winds the old abandoned Ghaut Road. It passed through this hill by a tunnel 284 yards long, and above that traversed some very rough ground to the summit, and presented a heavy section. In rising to the top of the Incline it passed along the western flank of the ravine at the head of the Beena Nullah, until it reached the level plain on the western side of the village of Egutpoora. The altitude of that Incline was 999 feet, and its length  $7\frac{1}{2}$  miles. The sharpest curve was of 30 chains radius, and the gradient was of a uniform inclination of 1 in 37.

It is unnecessary to make more particular mention of the works upon that Incline. I will only add that, in reporting the result of our labours, we took credit for having, generally speaking, discovered the best ascent of the mountains in the North-Eastern direction; yet we submitted our designs with a confident assurance that we should be able to effect considerable improvements by a further study of the Ghaut. During the season of 1852, the Company

likewise collected very complete returns of the traffic along the Bombay and Agra Road, which warranted us in expecting receipts to the amount of £1,224 per mile per annum, and a dividend exceeding the percentage of the guarantee. Appreciating the great commercial merits of the Railway communication along the North-Eastern route, I strongly urged the expedience of its early completion, and advised that the primary efforts of the Company should be directed to that important object. I regret to this day that subsequent proceedings should have so long retarded the construction of this line ; for if we had been permitted to begin our operations, as we could have done, in the year 1854, I might ere now have had the gratification of showing you the completed works of the Thul Ghaut Incline, with all the convenience and amenities of a Railway excursion.

The Thul Ghaut project met with so favourable a reception from Colonel Crawford, the late talented Consulting Engineer of the Bombay Government, from the Railway Board of Directors, and the Honorable Court, that there was a fair prospect of our advancing rapidly with at least this one important section of our Railway scheme. Other influences, however, were at work ; and while some officers of Indian experience were advocating the more pressing claims of the Poona Line, and urging its prior construction, one, who has since been professionally connected with a portion of our Western Railways, interposed in our proceedings, by publishing a memoir which was transmitted to the late Governor General, the Marquis of Dalhousie. I cannot introduce the name of that eminent statesman without respectfully expressing my humble admiration of the sound and comprehensive opinions concerning the Railway communications of India, which, with all the weight of his high office and acknowledged authority on the subject, he conveyed in his celebrated Minute of April 1853. The masterly treatment of the general scheme of Indian Railways, and the correct and far-seeing exposition of the merits and prospects of a bold extension of the system, will ever render His Lordship's Minute memorable in the annals of our public works ; for the Honorable the Court of Directors, who had hitherto only crossed the threshold of the enterprise, and had confined their operations within the narrow limits of experiment, were thereby encouraged to proceed upon the broad basis of the commercial and political interests of the Empire. If the aversion

which it expressed to the selection of the Thul Ghaut route led to a fruitless investigation, and if his cautious reluctance to entail upon one of the chief trunk lines of the Peninsula such an objectionable feature, as that Incline occasioned protracted delay in its construction, it must still be admitted that in the infancy of Indian Railways, and with his Lordship's responsibility in their establishment, there was ample reason for the hesitation with which he accorded his sanction to such an unprecedented project. Unfortunately for the Bombay Presidency the Railway under consideration did not lie within the scope of his personal observation. Had it done so, and could Lord Dalhousie have looked into the merits of the question for himself, I am satisfied he would have proved the best supporter of our present lines, and done much to expedite their completion. It unluckily happened that just when the Governor General was preparing that Minute which was destined to exert so great an influence over Railway enterprise, Colonel Kennedy's curious memoir invited his attention. With many blemishes, which did not escape Lord Dalhousie's notice, that paper contained some representations of a nature to arrest the judgment of the Council Chamber. The views taken of the reduction of State expenditure, and of the military and political advantages which were to be derived from the introduction of Railways along the main routes of the Empire, correct as they were in the abstract, were, however, combined with lavish promises of a magical rapidity in the construction of the Lines, and a fabulous economy in their cost; while the honest features of the Thul Ghaut route, with its rugged and costly Incline, were contrasted with the impulsive planes; 4 to 1 slopes, 1 in 2000 gradients, and all the other smooth and alluring merits of a new project, which, although it was to cross every river that rises in the Ghauts, from Bassein to Broach, was presented to the notice of the Governor General under the attractive appellation of a "Valley" Line! To that memoir a very able reply was addressed to the Bombay Government by Colonel Crawford in January 1853.

The objections which his Lordship originally took to our North-Eastern Extension may, in general terms, be stated as follows:— He disapproved of the Thul Ghaut Incline as a part of the trunk-line of communication between Bombay and other districts of India. He preferred the construction of a Valley Line along the course of the Nerbudda, or by way of Baroda and Neemuch; and



even for a local line, upon a *prima facie* view, he considered that the Taptee "Valley" route was likely to prove more eligible than that of the Thul Ghaut. We were accordingly directed to enter upon a thorough investigation of the comparative merits of the Ghaut and the Taptee Lines. This extensive inquiry employed our services during the working season of 1854, and it was characterised by Lord Elphinstone and his Colleagues in Council, as "the most important question that was likely to come before them or their successors for many years." Alive to the paramount interests that were at stake in the comparison, we made our departmental arrangements with the intention of thoroughly sifting the entire merits of the question, and then submitting the result. We thus had the good fortune to follow our opponents into court, and to gain the verdict of the judges. The case which had excited very general interest, both from the importance of the stake, and the influence of Lord Dalhousie's Minute, was opened by the advocate of the Taptee Line, and, I think, with injudicious haste; but Colonel Crawford, whose elaborate report of 31st May 1854 was published in the volume of Government Records of 1855, still continued to support the Thul Ghaut Scheme, and declared his reasons for consistently adhering to his preference. He demonstrated that it was the most direct line; that it occupied the route by which the traffic of the country was conducted; presented more places with which it was desirable to open a Railway communication, and passed through a more healthy country. He argued that, by omitting the Ghaut Incline as an exception, it was mile for mile cheaper to construct, and that there was every reason to expect it to prove a profitable undertaking.

This distinguished officer died at his post only 7 months ago; and it affords me unfeigned pleasure to bear my humble testimony to his able and judicious exercise of the authority of his office. The great interest which he always felt in Railway enterprise made him an earnest advocate of progress; while his wise supervision of the Company's transactions materially contributed to their success, and to the satisfactory working of the guarantee-system. It has frequently occurred to me that the decease of that gallant officer, who had rendered such long and valuable professional services in this Presidency, has never met with that marked degree of public notice which it deserved; yet I know that the respect and confidence which he inspired have sunk quietly and deeply into the minds of

the community, although no lengthened obituary has ever given expression to the severe loss the public service has sustained. Notwithstanding Colonel Crawford's explicit statement and advice, and without waiting for the representations of the Great Indian Peninsula Railway Company, the authorities of this Presidency decided for the Taptee Line, and recommended that a guarantee should not be granted to the Thul Ghaut Line. Not so, however, the Governor General, who suspended his judgment until our operations were complete, and the result submitted for his deliberation. This we did by a very full report in the autumn of 1854; and, reluctant as I am to occupy your attention with particulars possessing now only a retrospective interest, it is necessary, for the treatment of my subject, that I should succinctly lay before you the merits which ultimately secured the sanction of Government for the construction of our present Line. The superiority we claimed for our Line related to its length and the time of transit; the cost and period of construction; the working expenses; the traffic, fares, and gross receipts; and the annual return upon the outlay. We proved a saving of 131 miles in the distance, and of 5 hours for passengers, and  $7\frac{1}{2}$  hours for goods in the journey from Bombay to Khandeish; a saving of 149 miles of new Railway to be constructed within those limits, and of upwards of a million sterling in the outlay; and a permanent economy of £43,400 per annum in the working expenses of the Ghaut Line. We also demonstrated that, with the same amount of gross receipts, the profits of the direct Line would be  $8\frac{1}{2}$  per cent., as compared with  $3\frac{1}{2}$  by the Taptee Line; and that our project might be finished 2 years before the other. No sooner was this report delivered, than the fortunes of the Thul Ghaut Line took a propitious turn, and our success was consummated by Lord Dalhousie's frank adoption of our scheme. From the year 1855, when his decision was recorded, we may date our authority to proceed with the North-Eastern Section of our project.

Sanguine of ultimate success, in 1854, when we were engaged in this unlucky competition, we took the opportunity of effecting improvements in the ascent of the Thul Ghaut. We reduced the length of steep gradients upon it to the extent of  $1\frac{1}{4}$  mile, and also flattened the gradient for the lower  $1\frac{3}{4}$  mile from 1 in 37 to 1 in 40. We also improved the curves, and more than doubled the length of straight line on the ascent; and by these and other practical represen-

tations, mitigated some of the objections which the Governor General had entertained to the Thul Ghaut ascent of the mountains. Nor was this all we did to clear the ground for onward progress : we had not only been enjoined to defend our line against our Taptee rival, but were instructed to ascertain that there was no better route for ascending the Syhadree range in the north-eastern direction than by the Thul Ghaut. We consequently extended our surveys both to the north and south of our projected Line, and the result of those researches confirmed the superiority of the selection we had made. To the north of the Thul Ghaut the main escarpment of the Syhadree range forms a crescent whence the River Wyturnee descends through a deep, winding, and precipitous channel rent by the great gorges of several tributary nullahs. The River Wyturnee breaks near its source through the verge of the Ghauts, and although at that point its bed is upon a lower level than the top of the Thul Ghaut, the adjacent ravines and physical obstructions rendered it impossible for us to adopt it as our summit.

The Sheer Ghaut, a favourite route for traffic, was carefully examined, and a line laid out, which we called "the Dawandee Incline." It proved inferior to the Thul Ghaut ascent, having nearly double the length of steep gradients, and presenting upon its section a viaduct over the Wyturnee, which was 320 yards long and 200 feet high. The failure of this Incline, and the forbidding features of others to the north of it, defeated our endeavours to find a better line in that direction ; while to the south, between the Thul and Malsej Ghauts, our investigations were equally unsuccessful. Indeed, the whole of that part of the Syhadree range is of the most impracticable character. Its general elevation is higher than any portion of equal length which I have seen, and its escarpment is extremely precipitous, throwing out low and irregular spurs, and presenting no possibility of effecting a good Railway ascent. In addition to those objections at the Ghaut itself, the approach along the Concan must have traversed a tract of country of the most unfavourable nature. The course of the valleys could not be pursued on account of their tortuousness and the abruptness of their banks, entailing a constant succession of viaducts, tunnels, and heavy earthwork, with the continuous use of very sharp curves. If, on the other hand, the Line had been taken out of the valleys, the intricacies and unevenness of the ground would have aggravated the worst features of the section. It is no doubt unfortunate that our Bombay Railways are

driven to the necessity of crossing the Syhadree mountains; but lying as they do nearly at right angles across the line from Bombay to Calcutta, and projecting  $1^{\circ} 30'$  northwards of its due direction, this must be regarded as the inevitable result of the physical character of the country; and we have but little reason to complain, when we consider that, instead of a journey of 32 days for the conveyance of cotton, at Rupees 53 a ton, the Railway, which ascends the Thul Ghaut Incline, will enable our merchants to accomplish the same object in only 24 hours, and at little more than half the cost!

The Honorable Court's sanction for the construction of the Thul Ghaut Line was conveyed to us on the 31st of January 1856, three years after the completion of our first design, and the contract was let to Messrs. Wythes and Jackson in August 1857. In the mean time, we had been staking out the Incline, so that its construction might be commenced as soon as the Contractors, with their plant and agents, should take possession of the ground. While this operation was proceeding, an alternative course along the upper portion of the Incline was suggested by a closer examination of the Ghaut, and a long period was devoted to a thorough investigation of its merits. That route is represented thus — — — upon the Map; and although it was ultimately abandoned, it is worthy of notice on account of its having occupied much skilful professional service, and because it subsequently led to further delay in our proceedings. This alternative, which we call the "Cork-screw Line," was reported upon in September 1857. It presented the advantage of a maximum gradient of 1 in 60 instead of 1 in 37, but its curves were worse; the works upon it much heavier,—the tunnels being 1629 yards, and the viaducts 364 yards longer than upon the more direct Incline. It was  $3\frac{1}{2}$  miles longer; its estimated cost £2,37,635 greater, and two years more would have been requisite for its completion. Although the flatter gradient was of itself an important element of superiority, its increased length, cost, and period of construction more than counterbalanced its practical advantages; while the carrying power of the direct line was considered ample for the prospective requirements of the country. Our representation of the comparison between the original and alternative lines unfortunately failed to obtain the concurrence of the Government, to whom it was submitted; and the usual difficulty of "deciding when doctors differ" was encountered. The matter was referred to the highest professional authority in England, and Mr. Stephenson, who was consulted on the subject,

after a full consideration of the case, reported upon it in January 1858 to the Board of Directors, whom he recommended to adopt the direct Incline, with a maximum gradient of 1 in 37, in preference to our "Cork-screw alternative" with its 1 in 60. The first official intimation which I received of this settlement of the disputed question was conveyed to me by Lord Elphinstone, who inspected the Ghaut, and gave us full authority to prosecute our works with the utmost possible despatch, and our Incline has since assumed its permanent course.

I have now completed my narrative of our long preliminary operations in designing and establishing the merits of the Thul Ghaut Incline; and whereas upon the Bhore Ghaut I had chiefly to draw attention to the difficult and extensive character of the design, and to the physical obstacles of the mountain range which had almost defied the skill and exertions of our Engineers and surveyors, I have on the present occasion rather to impress you with a just idea of the official delays, difficulties, and doubts with which we have had to deal in the transactions of our Thul Ghaut project. In this respect, we find another element of difference between the two Inclines; for with greater and more numerous engineering impediments and disadvantages upon the Bhore Ghaut, we were so fortunate as to gain the much earlier approval of the authorities, and the consequence will be, that that Incline, which is laden with a far heavier mass of work, will win the race against our Thul Ghaut Incline, which is little more than half its length, and only half its elevation. X

The Railway Incline which we are now constructing at the Thul Ghaut commences upon the left bank of the Rotunda Nullah, near the Bombay and Agra Road, and proceeds over some heavy ground, with one tunnel, through the Lara Khind to the Mandashey Nullah, which it crosses by means of a large viaduct. It then perforates a high spur of the mountains by a long tunnel. Emerging from this, it passes over two rocky ravines, and through the intervening ridge by a tunnel. It thence ascends along the flank of the hills, which overhang the village of Kussara, and, spanning the Kussara Nullah by a viaduct, crosses the Thul Ghaut Road below the Toll House, and enters upon the site selected for the Reversing Station, between the Mail Road and the Paithur Nullah. The Reversing Station is very similar in its engineering and physical characteristics to that of the Bhore Ghaut, which is now sufficiently shaped out for

visitors to comprehend its peculiarities; and it will therefore be unnecessary for me to detain you with any further description of this device. From the Reversing Station the line strikes out at an acute angle through the Mussoba Khind, and rises by a curvilinear route along the northern flank of the lofty mountain called "Beulah," the spurs and ravines of which have necessitated the construction of several tunnels and two viaducts. After leaving our longest tunnel, which you will observe near the middle of the section, the Incline crosses the enormous gorge at the head of the Ehegaum Nullah by a viaduct of extreme dimensions; and, traversing very rough ground by means of high embankments and two tunnels, it enters nearly at right angles the spur up which runs the old Ghaut Road. With another tunnel through this hill it reaches the left bank of the Beena Nullah, which it crosses and recrosses by two bridges, and then ascends to the summit upon the open level ground close to the Mail Road on the western side of the village of Egutpoora. This Incline is 9 miles 26 chains long; the level of its base is 940 feet, and of its summit 1912 feet above high-water mark in Bombay, so that its total altitude is 972 feet. Its average gradient is consequently 1 in 56, that of the Bhoze Ghaut being 1 in 48.

The gradients, which are all ascending, are as follows:—

	Miles.	Chains.		Miles.	Chains.
Level .....	0	2	1 in 88 .....	0	35
1 in 60 .....	0	47	Level .....	0	20
Level .....	0	16	1 in 60 .....	0	10
1 in 60 .....	1	3	1 in 37 .....	4	29
1 in 50 .....	0	42	1 in 45 .....	0	13
Level .....	0	8	1 in 102 .....	0	70
1 in 60 .....	0	35	Level .....	0	12
1 in 148 .....	0	23			

The curves are—

	Miles.	Chains.
17 chains radius .....	0	33 long.
20 chains radius .....	0	47
Between 20 and 30 chains radius .....	1	33
30 and 40 chains radius .....	2	68
40 and 50 chains radius .....	0	10
60 chains radius .....	0	39
80 ditto .....	0	24

	Miles.	Chains.
100 chains radius.....	0	4
Straight .....	3	27

The works consist of 13 tunnels, of an aggregate length of 2652 yards, and of the following respective lengths :—

Tunnel No.	Yards.	Tunnel No.	Yards.
1 .....	130	8 ....	412
2 .....	490	9 ....	70
3 .....	80	10 ....	50
4 .....	235	11 ....	261
5 .....	113	12 ....	140
6 .....	123	13 ....	58
7 .....	490		

so that upon the two Ghaut Inclines we are at present making as many as 38 tunnels.

There are six viaducts, of the following dimensions :—

Viaduct No.	Yards.	Feet.
1 .....	66 long	90 high.
2 .....	143 „	84 „
3 .....	66 „	87 „
4 .....	66 „	90 „
5 .....	250 „	200 „
6 .....	150 „	60 „

The total quantity of cutting amounts to 1,241,000 cubic yards. The greatest depth of cutting is 60 feet, and the largest cuttings contain—

Cutting No. 1 .....	58,000	cubic yards.
6 .....	40,000	„ „

The quantity of embankment amounts to 1,245,000 cubic yards. Their maximum height is 90 feet, and the heaviest embankment contain—

Embankment No. 4 .....	190,000	cubic yards.
6 .....	90,000	„ „
18 .....	220,000	„ „

These details of the earthwork will be liable to alteration during construction, in order to provide for the security of the line by flatter slopes wherever the material may prove to be of a soft or treacherous nature. There are 15 bridges of various spans, from 7 to 30 feet, and 62 culverts.

The estimated cost of this Incline is about £45,000 per mile, and its completion has been contracted for on the 31st May 1863. The probable cost of the Bhoze Ghaut will be about £46,000 per mile. This presents conclusive evidence, that mile for mile the works of the Thul Ghaut are nearly as extensive as those of its formidable rival. The tunnels all contain trap-rock, and the two near the bottom of the Incline consist throughout of basalt of the hardest description. Of these, the Manda-Sheyt tunnel, 490 yards long, deserves more particular notice. The process of blasting the basalt, which it contains, was so slow, that it has been necessary, at considerable cost, to sink two shafts; and as these are charged with water during 6 months of the year, we find our operations encumbered not only with the difficulties of mining such extremely hard rock, for which steel drills are used, but also with the contingency of pumping. It is probably upon this work that the completion of the Incline will ultimately depend; and, situated as it is near the foot of the Ghauts, and attended with every disadvantage, it will call for the utmost exertions and perseverance to accomplish, in due time, that important object. The only other tunnel upon which I shall offer any observation is the long one near the middle of the Incline. Its great length formerly led us to regard it as the key to the opening of a Railway communication up the Ghaut; but on proceeding with our mining operations, we fortunately discovered that the mass of the hill consisted of rock of a favourable nature; and the consequence has been that, although the work was not begun until March 1859, we have already carried a heading through 258 lineal yards, or about five-ninths of the total length of the tunnel in one year and a-half. No progress which we have hitherto attained has equalled the rapidity with which this tunnel has been executed; so you see a prize may be drawn even in the lottery of Ghaut contingencies.

Of the six viaducts, there are three to which I invite your attention. The Manda-Sheyt viaduct, at the entrance to the tunnel of that name, is a large structure, already in a very forward state. Tackle, of a workmanlike description, to hoist the materials for the masonry, has been fixed at each pier. Tramways have been laid in various directions from the adjacent quarries, smitheries, carpenters' shops, masons' sheds; and labourers' huts have all been erected. By these means the execution of the work has been both expedited and economised. I trust that you will excuse me for touching upon



such particulars as these ; but, remembering that I am in a foreign country, where mechanical appliances are so rarely to be met with, it cannot be amiss to draw attention to any operations upon which the skill and experience of English management have been displayed in new and effectual executive arrangements.

The great viaduct over the Ehegaum Ravine is distinctly marked upon the Section, and will be more intelligible to you in the special drawing which I have exhibited. I believe it to be the highest viaduct that has been designed in India. The level of the Railway is 188 feet above the surface of the ground, and as we have a depth of upwards of 20 feet to excavate for good foundations, the two central piers will be 200 feet high. The iron girders will be on Warren's principle, and 150 feet in span from end to end. I do not propose to occupy your time with a description of them especially, as I know my friend Mr. Terry intends, in the course of the season, to read a Paper upon this interesting subject. You will, however, readily discern one practical difficulty which lies before us, in having to lift the girders from the bottom of the ravine to their resting place upon the tops of those lofty piers. The difficulty of the problem consists not so much in the weight of the girders (each of which may be calculated at about 32 tons), but in the following peculiarities—that the triangular girders, strong as they are when framed complete for sustaining a vertical pressure, are laterally very weak ; and that the ends of the girders, which are to bear upon the piers and abutments, must be carried up through recesses in the masonry. To obviate the imminent risk of damage to the girders from lateral motion while they are being lifted separately so great a height as 200 feet, we have made our arrangements for hoisting them in pairs, so that they may be stiffened by those connecting parts which are intended to steady them, when the permanent road is laid. To lift them in pairs, as we propose to do, will require a recess 8 feet 6 inches wide, and 4 feet deep in each side of the piers, from the surface of the ground to the bed of the girders ; and you will thus observe that the design of the piers, themselves of that enormous height, has demanded careful study. The plan we have adopted is to build a rectangular pier 15 feet 6 inches thick, with two counterforts at each corner of the recesses. By this means we have not only strengthened that part of the pier which would be endangered by the existence of the recesses, but without adding materially to the quantity of

masonry, we have increased the steadiness and stability of the whole structure by widening its base. The lifting-power to be employed might consist either of crabs or screws, but as the motion of the screw is so smooth, and its action so regular, we intend to use it for hoisting, and crabs for securing the girders against any accidents in the process. The screw will be placed upon the top of the pier, and immediately over the recess. From it will be suspended strong iron links, each several feet in length, down to the top table of the girders; the lifting will then commence, and as the girders ascend, they will be propped from stage to stage, and the links be successively disconnected as the girders rise in pairs towards their bed upon the viaduct. Should any casualty happen in the performance of this operation, we shall be prepared with crabs and derricks and strong chains to keep a constant hold of the girders, and thus prevent any fall or jerk while they are suspended on the lift. The present condition of this stupendous work is already worthy of examination, from the admirable arrangements which the Contractors (Messrs. Wythes and Jackson) have made for its execution, and in which the peculiar form of the great ravine has afforded them extraordinary facilities. As it advances, the proximity of this colossal viaduct to the public road, the magnitude of its dimensions, and the peculiarity of its design, will, no doubt, be deemed by many travellers a sufficient inducement to pay a visit to the scene of operations; and the viaduct will, I trust, when finished, with its iron superstructure and its lofty stone piers, be no unworthy memorial of the bold enterprise and practical skill of our countrymen, as well as of the excellent materials and industrial classes of India.

The last viaduct, concerning which I shall offer a few remarks, is that which you will find upon the section at the upper end of the tunnel under the old Thul Ghaut Road; and although its design presents no peculiar feature, its position is remarkable, for it will stand upon a rock scarp overhanging the gorge of the Beena Nullah. The cross sections (Nos. 491 to 495) represent the abruptness of this precipice, and will show you why a viaduct was substituted for an embankment, and how the piers and abutments are notched and bedded into the rock escarpment.

In the earthwork there is little to claim your attention, except the mode by which large quantities of material are tipped into such high embankments, as those three which you see near the base and middle of the Incline. These will be found worthy of

your inspection, if, when the Railway is opened to Kussara, you should be induced to pay a visit to the works of this Incline. The material of which they are made has to be procured from the bottoms and sides of the adjacent hills at suitable and various levels ; and from the faces where these side cuttings are excavated, temporary waggon-tramways are laid to the embankments. The extent to which this expedient is adopted will, I have no doubt, astonish all who are not familiar with English Railway operations ; for in one of the large embankments there are 27, and in another 16, different lines of tramway in daily use for the conveyance of the earth. The lofty embankment which you observe upon the section above the Reversing Station is likewise remarkable, for it will have to be made in such a manner as to carry two double lines of Railway, one of which will stand at an extreme height of 51 feet above the other. It will also present another peculiarity, for the lower Line upon one side of the embankment will ascend towards the Reversing Station, while the upper Line will rise rapidly away from it. Upon the Bhore Ghaut Incline you have, no doubt, seen the large viaduct which spans the public road a quarter of a mile above the Toll House. That viaduct corresponds, by a close analogy of position, with the embankment which I am describing upon the Thul Ghaut Incline, and it may therefore be interesting for me to explain the reason why in one case a viaduct should have been designed, while in the other the object is effected by earthwork. At the Bhore Ghaut, the railway at that point stands upon the narrow crest of a hill, and if an embankment had been made, its slopes would have descended the mountain sides to an enormous depth, and its stability have been constantly endangered. Upon the Thul Ghaut, on the contrary, the two Lines, which are in close contiguity on emerging from the Reversing Station, pass over a nearly level plot of ground, affording a safe and firm basement for the bank. We have therefore economically adopted that course which would, as I have shown you on the Bhore Ghaut, have been attended with so much damage to the permanent safety of the Incline.

In my previous Paper I alluded to the extensive slips which were apprehended upon the slopes of the Bhore Ghaut cuttings ; and in that respect, the works of the Thul Ghaut present the same demand upon the vigilance and precautions of our Engineers. To any one not conversant with the details of the works, the appearance of these

casualties would, no doubt, give rise to serious misgivings concerning the ultimate security of portions of the Railway; but bear in mind that we, who are engaged in these extensive operations, have the ground constantly before our eyes, and its every movement becomes as familiar to us as those of a vicious horse to its own groom. You may rest assured that the practice and experience of several years, and the instructive effects of our heavy monsoons, will enable us to overcome the contingencies of the Ghaut hill-sides with at least as much success as Rarey has achieved in the handling of his patients.

I thank you for the attention with which you have listened to my long history and description of the Thul Ghaut Incline, and if I now mention the names of all of my colleagues in the Engineering Department of the G. I. P. Railway, who have taken part in our operations, it may, perhaps, give you some idea of the great amount of professional labour that has been bestowed upon a section of only  $9\frac{1}{2}$  miles of railway. They are Messrs. Ker, Graham, Darke, W. J. Wright (*deceased*), Inglis, Sanderson, Butt, Gale, Winteringham, Dickenson, A. A. West, Tate, F. A. Hawkes, Teasdale, Dangerfield, O'Brien, Cameron, Thompson, and Pocock.

If to this list of officers I were to add the names of our Contractors, and all the agents they employ, you might readily comprehend by what a powerful combination of labour, experience, and ability the battle with this gigantic undertaking will be won. It is a common saying that the word "impracticable" has been struck out of the vocabulary of the Engineer, and it is, I believe, a truth that any scheme within the proper limits of mechanical philosophy, which the ingenuity of man can devise for effecting a definite object, or for furthering the legitimate purposes of life, can be achieved by the skill and exertions of our practical men, and by the appliances which modern experience has put into their hands.

Above all, however, there is one element of our unity and strength—one talisman of our success—the great name of Stephenson! This is the first and a very appropriate occasion for me publicly to declare how much the Railway system of Western India owes to our late Consulting Engineer. It was mainly upon the favourable report of Robert Stephenson that the Government resolved to take the bold step of introducing Railways into this country. They were then regarded merely as experimental, and strange notions had been formed of their incompatibility with the means and habits of the people; yet, encouraged by his opinion, the Govern-

ment of the day entered into that contract with the Great Indian Peninsula Railway Company which has formed the basis of our subsequent proceedings. It was Robert Stephenson who created the large professional establishment by which our designs and works are being accomplished. He it was who, with the able aid of George Berkley, our present Consulting Engineer, adopted and procured those vast supplies of mechanical appliances which the British Islands have contributed to our wants. By his influence, and the shelter of his prestige, we were enabled to find eminent contractors to undertake the execution of our extensive works; and it was to his counsel the Government appealed with confidence in any doubt or difficulty that beset the prosecution of our plans. He, indeed, has been the one great bond that has cemented all the practical members of the executive of this immense concern, just as his experience and example, and those of his distinguished father, have constituted the principle of all our designs and operations. When I visited him last year, he thoroughly acquainted himself with the details of our Ghaut Inclines, and although I had previously felt considerable anxiety lest his long familiarity with works on a gigantic scale should lead him to entertain a less flattering appreciation of our Ghaut Ascents; yet, to my infinite delight, I discovered that he of all men was the one who formed the most accurate and generous conception of the magnitude and difficulty of those undertakings. I deeply lament that he was not permitted to fulfil his intention of visiting this Presidency; for while he would have witnessed for himself the progress of our works, several public projects of Bombay would have derived inestimable benefit from his presence and advice.

After a connection of 11 years with Indian Railways, and within a short period of the completion of our Ghaut Inclines, I grieve to say that we can now no longer look for his influence to support, his example to guide, his advice to help, or his approbation to animate us in our arduous labours; still, if his loss be great to us, who are conducting merely one small section of the Great Railway System of the age, how severely must it be felt throughout that wide range of public undertakings with which he was identified? Nor is it alone in connection with his own works that we can form a just estimate of his claim upon the gratitude and admiration of his country. His professional life displayed a powerful inventive intellect, a sound judgment, a clear perception and philosophical

appreciation of facts, a thorough knowledge of physical laws, a strong grasp of science, which made it subservient to all the practical purposes of his essentially useful projects, and a strict regard for that wise economy, which, aiming not solely at saving money, keeps expenditure in its due proportion to every important feature of the scheme. These were undoubtedly precious gifts, but the influence and position they acquired, were strengthened by a noble disposition, which won for him the zeal and attachment of all whose agency was instrumental to his great designs, and the esteem of every one with whom he was associated. All his dealings with men of business were characterised by fairness and generosity; and who can fail to admire that fine balance of mind, which imparted to his decisions the accuracy of law, yet tempered them with the experience and sympathies of the man? His magnificent railways in all parts of the world,—his colossal bridges—the Berwick, the Newcastle, the Victoria, and the Britannia—these are lasting monuments of his fame; but his greatest triumph was the establishment of a general and acknowledged principle of equity in the control of public works, which derived its force and prevalence from his illustrious career. It may be difficult for the present audience to attach this result to the practice and example of Robert Stephenson; but there are thousands in England, who, from their own personal experience, will heartily concede that honour to his reputation. And let not the value of this principle be disparaged. It has tended in a remarkable degree to aid public enterprise by commanding the extraordinary resources of capital; by extending the powerful agency of the contract system; by concentrating the skill and exertions of vast bodies of able men, drawn from the working classes of England; and by establishing a feeling of confidence between them and their employers. If the progress of such grand undertakings as have left our age without a rival in the history of the civilised world is to be maintained, then the sterling principles of equity, and the just appreciation of the interests of others, which contributed so much to Stephenson's renown, must continue to be the guide of all who may succeed him in conducting them. Forgive the fervor of my language, while I express an earnest hope, that so long as those tunnels, which we are now piercing through "the everlasting hills"; so long as those massive structures, which are now uprearing their lofty forms in the ravines and depressions of our Western Ghats, shall endure, may the honoured names of George and Robert Stephenson

be remembered in this distant region, which will assuredly prosper, even as their native land has prospered, by their genius!

Ere I conclude my Paper, permit me once more to recall your attention to the subject of the Ghaut Inclines. They are incomparably the most important sections of the Railway communications of Western India, and by breaking down the great barrier which now intercepts the stream of trade, their commercial value must render them a boon to this country, and a blessing to the people. Yet these stupendous works, and, indeed, the whole Railway System of India, are being executed almost entirely with British Capital, under British management, and by the instrumentality of British Officers. It is not my object to appeal to the pride, but to the interests of our Native community; for if they will only consider the effects of this arrangement, they cannot fail to discern the disadvantages of an inert submission to its continuance, and the expediency of an early effort to stimulate and improve the prosecution of their Public Works. The Viceroy of India has just announced that "necessary and useful public works are deferred, and others calculated directly to improve the revenue, and to which the Government was pledged, are suspended": but if "Hercules cannot help them, will they not help themselves?"

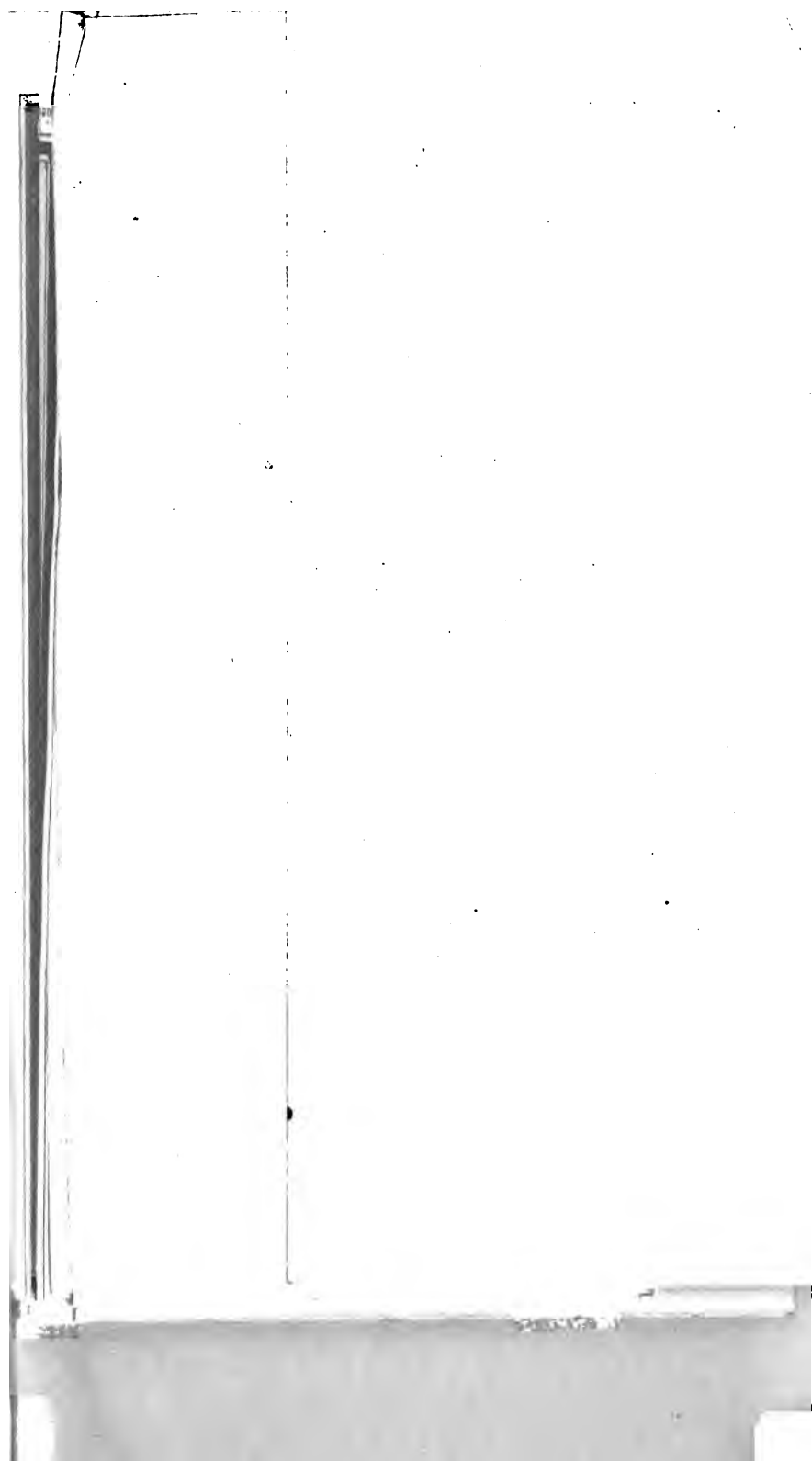
In the first instance, let us examine the important element of Capital. They surely cannot be so infatuated as to suppose that by leaving the execution of Railways to be effected with foreign Capital, they are gaining any permanent financial benefit by the bargain. The money of England is certainly contributed with a lavish hand; but let the Natives remember, that it is raised under a Government guarantee; and that if, on the one hand, Railways are unprofitable, it is they who must in a great measure discharge the liabilities of the State; while, if successful, they will have no participation in the profits. Take again the problem of the Public Works Loan. A large proportion of our Native millionaires are thereby shareholders in extensive schemes, with a Capital of 275 Lacs of Rupees, which they neither project, manage, nor control, and yet have to contribute to the payment of their own dividends.

Now look at the privileges the natives lose by consigning the management and execution of these works to foreign hands. The legitimate control they would possess over important national concerns,—the patronage, the experience, the influence of high directing offices,—the power of extending the employment of Native

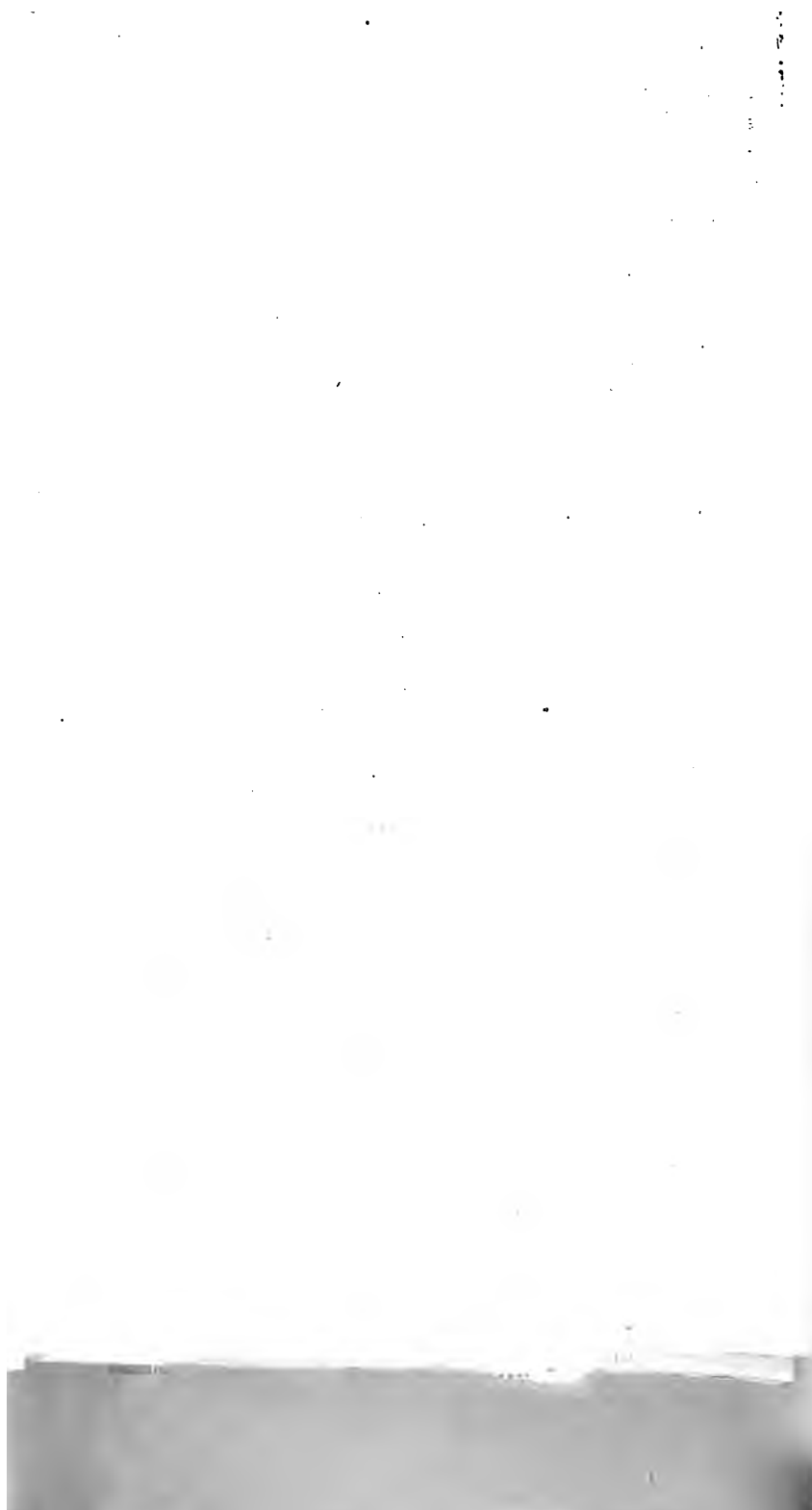
Agency, and of promoting the convenience and interests of their fellow-countrymen,—are all abandoned; and opportunities that might raise them in the social scale, and give them weight in the conduct of affairs, are unwisely foregone without any countervailing benefit. Identified though I am with the system that has hitherto prevailed, still I can confidently express my own conviction, that nothing could more surely and rapidly promote the prosperity of this country than the strenuous efforts of the Native gentry to assist in carrying out some of those undertakings, which the advancement of India now so urgently requires; and an experience of 11 years enables me to assure them that they may now boldly embark in many useful projects, with every hope of a successful issue. Recent symptoms of a growing spirit of enterprise encourage the belief that ere long we shall find them associated in projecting some portions of their railways, in works of irrigation, coal and iron mines, gas-works, as well as other manufacturing and commercial schemes. The difficulties in their path may be easily surmounted. Abundance of the best materials in the world, and plenty of excellent labour, are afforded by their own country; while the talent to design, and the agency to execute, are as procurable by Native, as they are by British gold.

I humbly, yet earnestly, hope that this counsel may not fall on unwilling ears; for my views, believe me, are neither illusory nor ill-timed. The sceptre of India is now swayed by a benignant Sovereign, whose constant and loving care is to promote the happiness and welfare of Her Majesty's subjects of every race, and whose government regards a flourishing commerce, prosperous manufactures, and thriving agriculture, as the chief sources of wealth and glory to the Nation. By the value of natural productions, the power of science and invention, and the force of enterprise, Great Britain has attained her present proud position, and by the same means will her Statesmen endeavour to elevate this richly endowed, though unenlightened Empire, to its true level of grandeur and civilisation!





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1949  
1950



1911

